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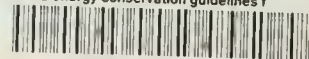
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STATE OF MONTANA
DEPARTMENT OF ADMINISTRATION

THOMAS L. JUDGE
GOVERNOR

CONSTRUCTION & MAINTENANCE DIVISION
1500 SIXTH AVENUE, HELENA, MONTANA 59601
TELEPHONE (406) 449-3104

February 9, 1979

Gentlemen:

As many of you know, the last legislature appropriated \$200,000.00 to the Department of Administration to conduct a statewide Energy Conservation Study. Although funding limitations dictated that the emphasis be given to existing buildings and the subsequent implementation of a retrofit program, the importance of workable energy guidelines did not go unnoticed. Therefore, the decision was made in the early stages of the project to devote a portion of the funding toward publication of an effective set of guidelines.

Since most of the suggestions herein can be implemented at little or no cost, they constitute an easy energy savings. These are the things that should be done before cost saving measures are attempted through retrofit. I realize that some of you have already established similar guidelines and are reaping the benefits from them. The results I have seen where this type of measure is enforced prove to me that significant budget savings are attainable.

I am hopeful that publication of these guidelines will provide the incentive for even greater energy savings in state-owned buildings. Participation and reduction by each and every state facility is a necessary goal.

Finally, I appreciate the cooperation you have shown to this point in our program and I urge you to continue. I am confident that together we can solve many of our problems and establish a comprehensive long term energy conservation program.

Sincerely,

A handwritten signature in black ink that reads "Philip H. Hauck". The signature is fluid and cursive, with a long horizontal line extending from the end.

PHILIP H. HAUCK, AIA, Administrator
Architecture and Engineering Division

TOM B. O'CONNELL, Chief
Facility Planning Bureau

DEPARTMENT OF ADMINISTRATION
Architecture and Engineering Division

pab



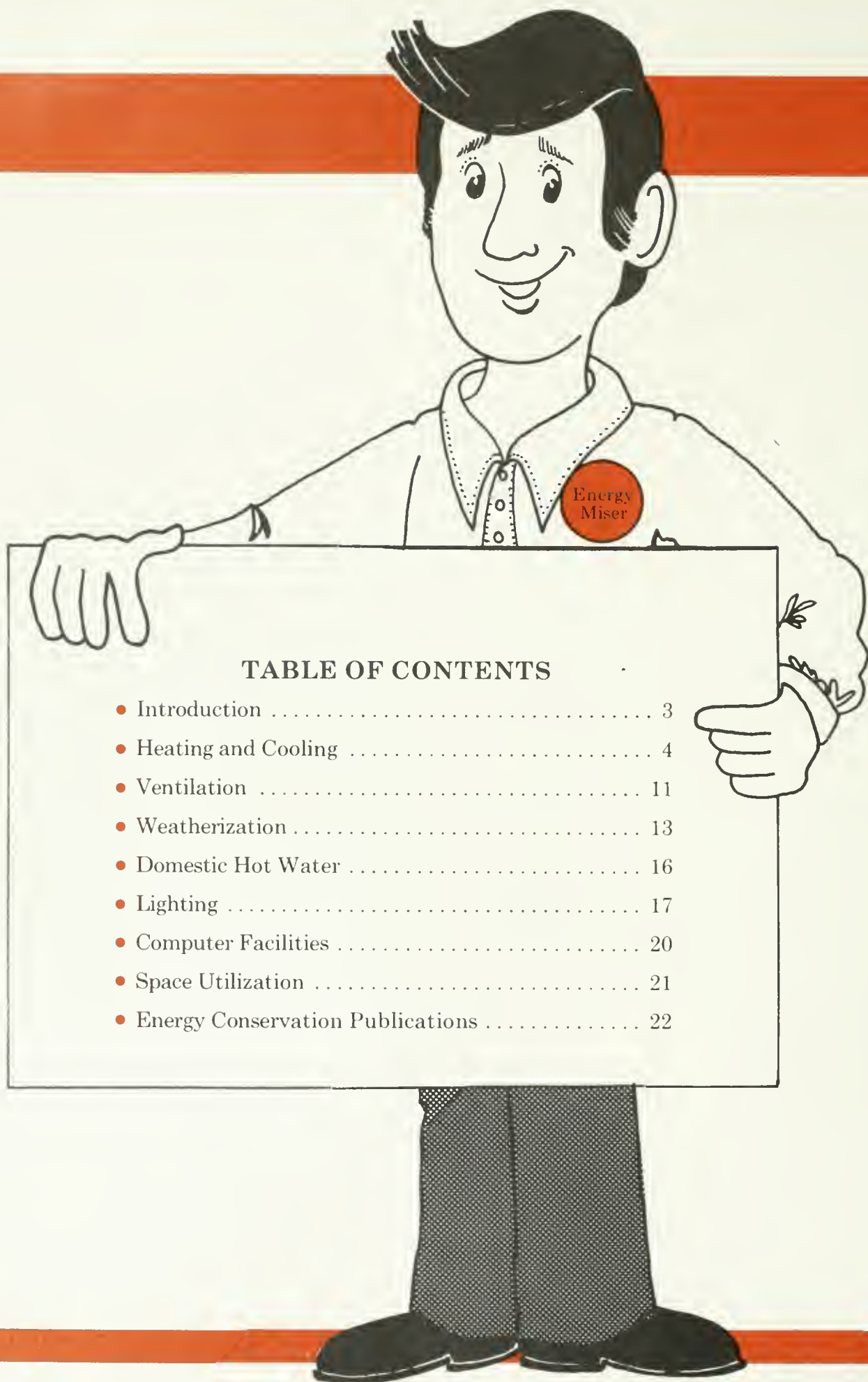


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Introduction

ENERGY COSTS are skyrocketing and show no signs of leveling off. This booklet can't lower prices, but it can show you how to use less of an increasingly scarce and expensive commodity. Utility records of state institutions that have adopted the practices recommended in this book have shown reductions in energy use of up to 30%. This translates into a substantial savings of money at today's prices and will soon mean even more.

Because of low energy costs in the past, buildings were generally designed and constructed on the basis of low first costs. It is because of this, that most state buildings use excessive amounts of energy by today's standards. Even though new buildings are being constructed for more efficient energy usage, the replacement rate is low and the majority of buildings

for a long time to come will be those built before the energy crisis.

It is for this reason that energy conservation in existing buildings is so important.

The guidelines in this booklet are practical. Common sense and an understanding of how the buildings' energy systems operate are all that is required for implementation of these methods. It is strongly recommended that time be spent with manufacturer's literature and that professional assistance be obtained if need be to find out the capabilities of the present system and the effect of modifications. A brief description of common HVAC systems and methods for conserving energy for each system has been included.



HEATING AND COOLING

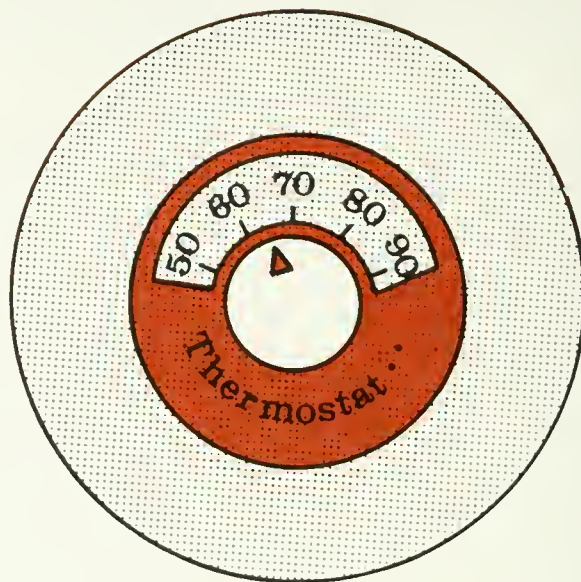
Heating and cooling generally represent more than half of a building's total energy use with heating being the prime consumer in Montana's climate. Significant savings are possible simply by adjusting controls. A conscientious maintenance program is also necessary to ensure that equipment is operating as intended.

Indoor temperatures should be set at 65°F. during the heating season. Night setback to 55°F. and weekend setback to 40°-45° is also recommended.

Air movement is a determinant in comfort conditions. At reduced thermostat settings, air flow rates in air systems may have to be reduced to achieve acceptable comfort levels.

The building should be preheated to within a few degrees of 65° before the building is occupied. Internal gain from lights and occupants will help bring the temperature to 65° during the first hour. Switch to night setting during the last hour of the day. Further reduce temperatures whenever possible; 55°-60° in storage areas, lobbies, corridors, and vestibules, 40°-50° or eliminate heat entirely in garages, docks and platform areas. Restrict use of portable electric heaters. Install guards on thermostats to eliminate tampering.

Close curtains or blinds whenever the sun is not shining during the winter. This will reduce heat loss and increase occupant comfort by reducing radiative loss.



Set indoor temperature to 80° during the cooling season. There should be no mechanical cooling when the building is not occupied. Outdoor air can be used at nights to precool the building during the summer months.

Reduce internal heat gain. Kitchen personnel can cooperate by planning meals that require less heating. Machine operation and other sources of heat should be re-scheduled to unoccupied hours or the end of the day, when possible.

CAUTION

Check system operation to make sure that recommended temperature settings do not cause reheat in summer or excess cooling in winter. For example, if cooling is provided an interior room having no heat loss will require cooling all year long and should therefore have its thermostat set at 80°F all year long.



- Insulate duct work (especially where it passes through unconditioned space).
- Reduce air flow resistance by replacing restrictive grilles and outlets with low resistance types; old filters with high efficiency filters, and changing out restrictive duct work.
- Reduce fan power requirements by reducing air volume to minimally acceptable levels.
- Adjust fan to be compatible with reduced load; consider new fan if load requirement is less than 60% of nameplate rating.

FUEL BURNING EQUIPMENT

The efficiency of fuel burning equipment depends to a large extent on proper maintenance and adjustment of the burner and controls.

- Adequately insulate the containment vessel to minimum R-20.
- Adjust air/fuel ratios for maximum combustion efficiency.
- Use electric ignition pilots rather than standing pilots.

CONTROLS

Controls are another area where initial costs have frequently been considered more important than resultant energy use of the system. Inadequate maintenance has also contributed to the problem and controls often need to be readjusted.

- Inspect and calibrate entire control system at least on an annual basis.
- Replace manual controls on heating system with automatic controls.
- Modify to provide control functions described for the various HVAC systems. This includes time clocks and controls for night and weekend setback.
- Consider adding an automatic draft damper control to the boiler or furnace flue.



VENTILATION

Ventilation is a major determinant of total energy consumption. In fact, ventilation loads frequently exceed conduction losses during occupied hours. Major factors to consider in evaluating ventilation systems are adjustment of minimum outdoor air settings and readjustment of control sequences.

Changes in building code and variances between building design conditions and actual use frequently permit a reduction in ventilation air. The State Energy Code references ASHRAE Standard 62-73 "Natural and Mechanical Ventilation", for minimum ventilation requirements. In most situations, 5 cfm of outdoor air per occupant is adequate. Higher ventilation air quantities may be required for spaces with positive exhaust systems such as toilets, baths, lobbies, corridors and kitchens. This air may be supplied from adjacent spaces as long as the sum of the ventilation requirements for the exhausted space and the adjacent space is provided.

Exhaust rates may be reduced as long as minimum ventilation requirements are met.

Minimum outdoor air settings should also be adjusted to agree with lowest settings permissible. Compare ventilation and exhaust rates to make sure that a slight positive pressure is maintained when exhaust systems are operating.



Each mechanical supply and exhaust ventilation system should be equipped with a readily accessible means for either shutoff or volume reduction when full ventilation is not required. Consider retrofitting controls if this function is not provided.

If excessive outdoor air is being provided for odor control, reduce ventilation air to minimum settings and install chemical or activated charcoal odor absorbing devices.

Check outdoor air dampers for tightness and damper position indicators for accuracy of the minimum setting. Outdoor air dampers should be closed during the first and last hours of occupancy. An override can be incorporated to open the dampers for the economizer cycle if cooling is required during this period.

Garage and shop areas have high ventilation requirements regardless of use. Installation of a carbon monoxide monitor to control make-up and exhaust units will result in considerable savings.

Ventilation rates are also high for indoor pools to provide humidity control. A pool

cover for periods of non use would reduce humidity levels and heat loss. A humidistat control would operate the ventilation system only when it was required for humidity control. If operating hours are still high after installation of the humidistat, heat recovery from exhaust air should be considered.



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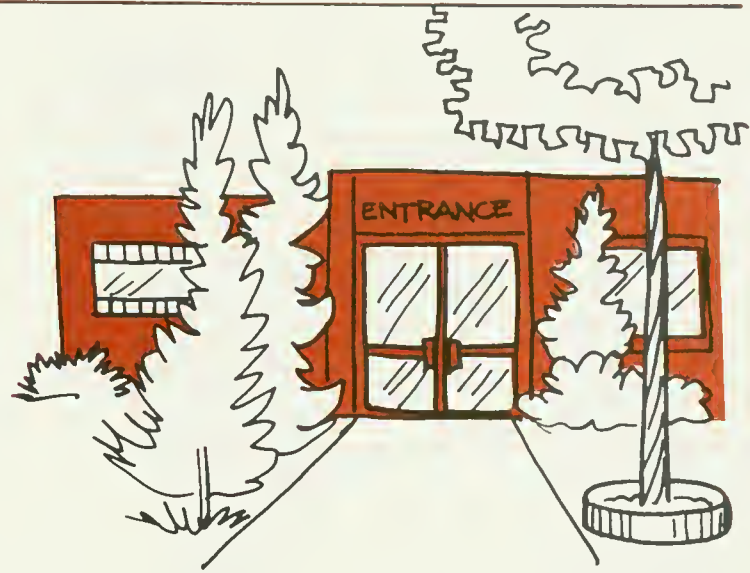
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WEATHERIZATION

Infiltration is a major source of energy loss which cannot be controlled by the occupants of the building. Infiltration includes air leakage through the building shell and air that enters through opened doors. The leakage occurs around windows and doors, through cracks and through floors and walls. The amount of infiltration is dependent on type of construction, workmanship and condition of the building.

The air flow rate into and out of a building depends in part on the pressure difference between inside and outside and on resistance to air flow within the building. The pressure difference can be due to wind or temperature differences between inside and outside air (referred to as stack effect) or to both forces. When wind is the major force, air enters through openings in windward walls and leaves through openings in leeward walls or low roofs. When the driving force is indoor-outdoor temperature difference, the flow in a heated building is up from low inlets to high outlets along the path of least resistance.

Thermal forces are a major factor in tall buildings. Interior partitioning does not change the total stack effect for the building, but internal flow resistance will reduce the pressure difference across the interior wall at any level. The stack effect of tall buildings is highly dependent on vertical shafts such as elevators so increasing resistance to air flow into and out of the shafts will reduce infiltration.



Wind forces can be reduced by installing wind screens around entrances. Wind screens for the buildings should also be considered as part of the landscape planning.

Infiltration losses can be reduced by making the building more airtight. Consider the following items:

- Inspect for cracks and air leaks in and around windows, doors and walls. Weatherstrip or caulk as required.
- Check gasketing and cam latches on operable windows for tightness.
- Inspect automatic door openers. Consider adjustment to speed closing.
- Check alignment of doors and windows.
- Install storm windows. Applying tight storm windows to poorly fitted windows can reduce air leakage by 50%.

- Much infiltration occurs around poorly sealed overhead doors and through open doors such as those used for delivery. Consider sealing off doors that are seldom used. If possible, reduce the size of delivery entrance. Expandable enclosures for delivery ports are worthwhile if usage is high.
- Vestibules greatly reduce infiltration at doorways and should be used on all major entries where space permits.



Glazing

Consider obtaining professional assistance before attempting glazing modifications. There are many trade-offs involved between the relatively high heat loss and heat gain of the glazing area and other factors such as natural lighting and building function.

- Block off and insulate unused windows.
- Close blinds and drapes during the heating system whenever the building is unoccupied to reduce heat loss.
- If excessive heat gain is a problem, consider installation of reflective and/or heat absorbing film. Installing the film on a roller instead of directly to the glass would provide selective control for full heat gain during the heating season and an air space for reduced heat loss.
- Consider external sunshades that are adjustable to reduce heat gain in summer but not during the heating season.
- Consider replacement of single pane windows with double or triple glazing.

Insulation

Obtain technical assistance if need be to maximize the energy and economic effectiveness of insulation modifications. Beware of potential problems with moisture condensation and add new vapor barriers as required.

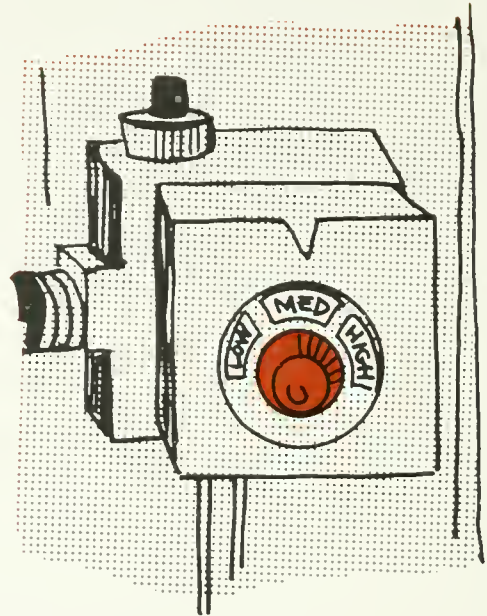
- Insulate built-up roof systems when reroofing. Consider insulating above the top floor ceiling if space is available with a vapor barrier at the ceiling.
- Determine feasibility of adding insulation to existing exterior walls; especially when remodeling.
- Consider insulating other partitions between conditioned and unconditioned space such as floors over garages and storage room walls.



DOMESTIC HOT WATER

Energy costs attributable to domestic hot water can be reduced by lowering conduction losses and water use.

A quick way of reducing conduction losses is to lower generating and storage temperatures to 100-105°F. Inspect insulation on storage tanks and piping. Storage tanks should be insulated to R-20. Pipe losses are not as critical since much of the loss is to conditioned spaces, but there should be ½"-2" of insulation depending on the size of the pipe. Turn off the circulating pump with a time clock when the building is not occupied. Inspect and test controls to assure proper functioning.



Reduce end use by installing flow restrictors and spray type faucets. Check the system for leaks, including faucets.

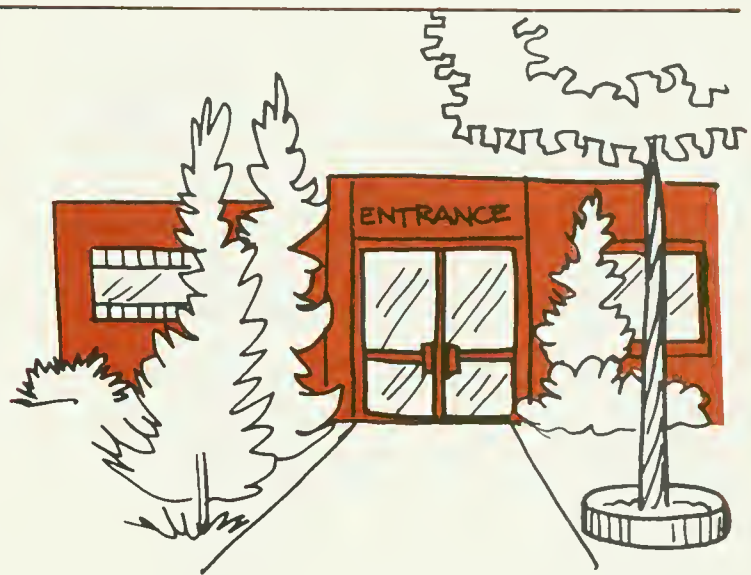


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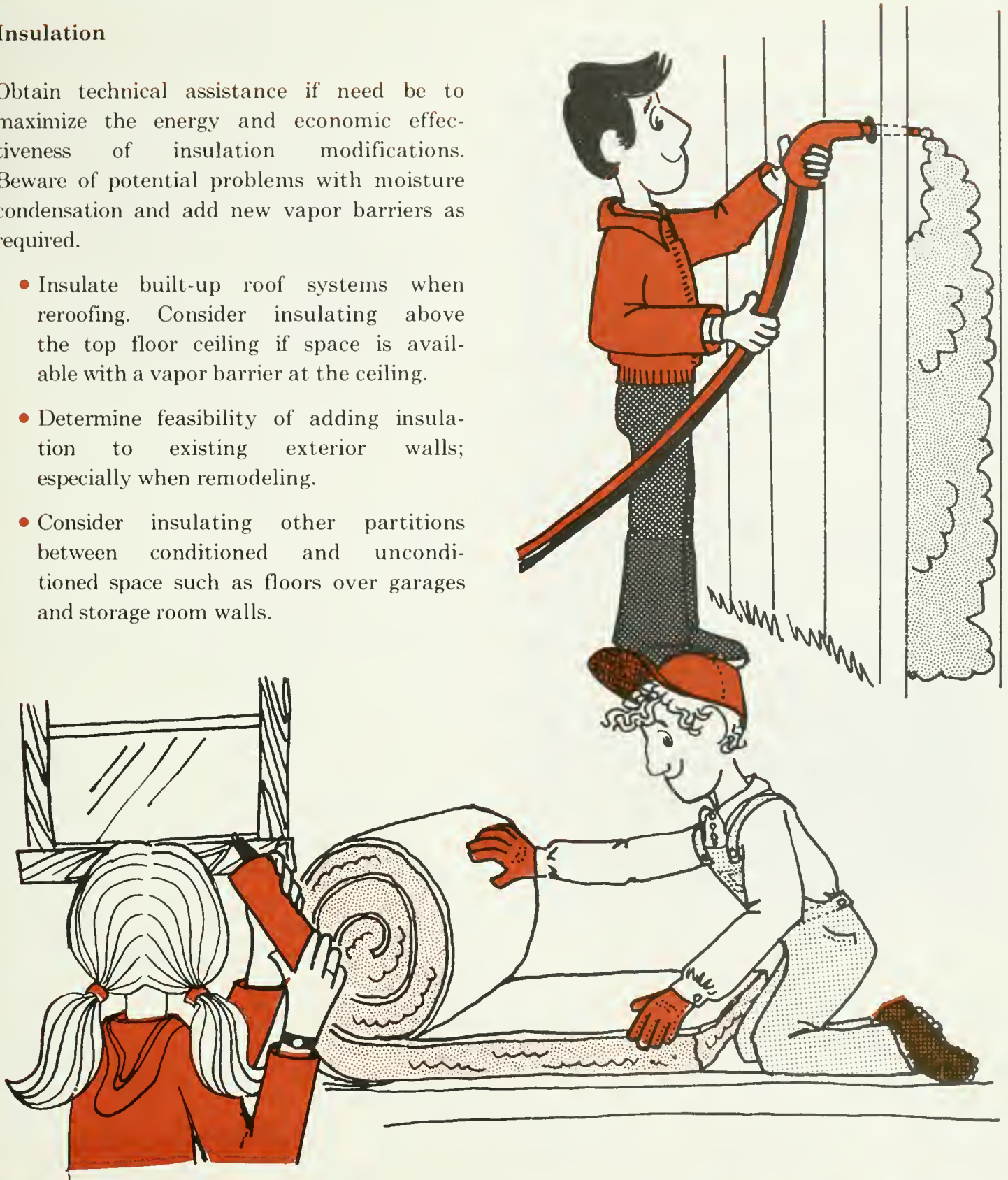
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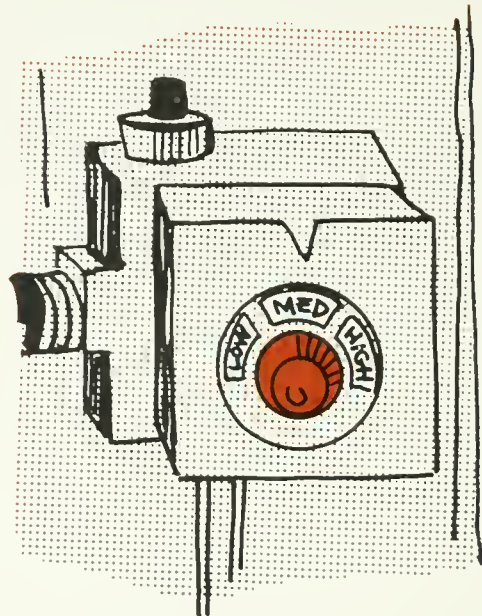
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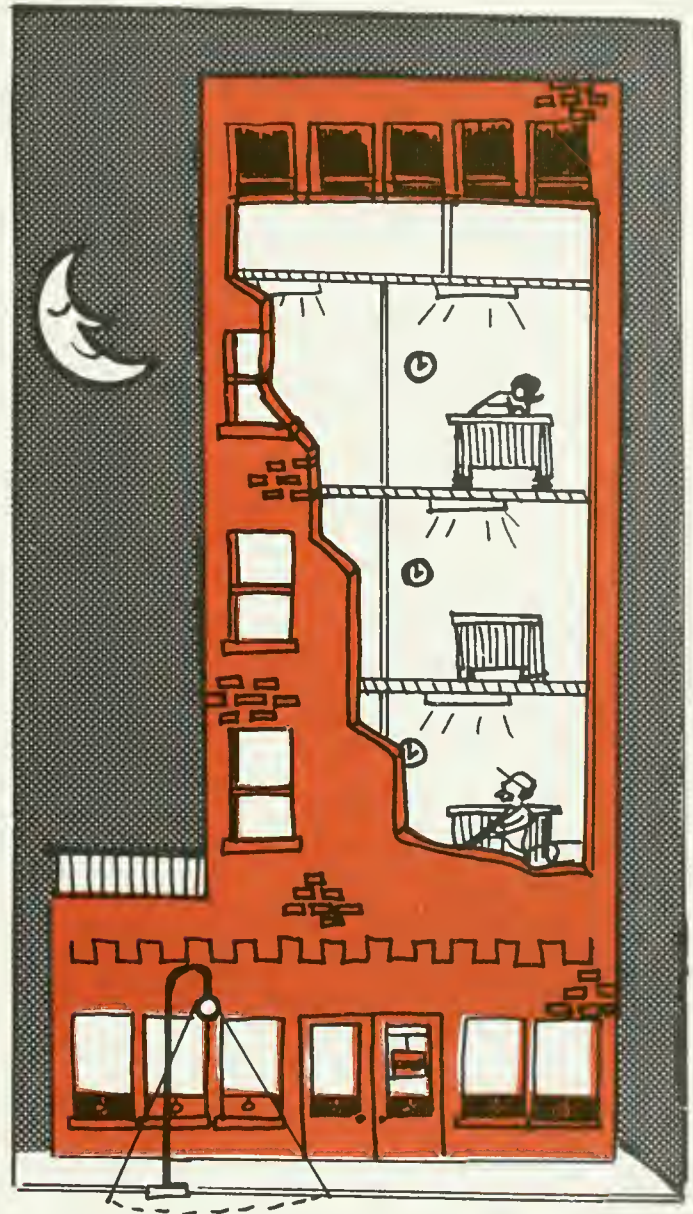
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SPACE UTILIZATION

The manner in which the building is used will have a strong effect on energy usage. The following items are typical of the many that need to be considered.

- Coordinate scheduling of building space to maximize use of conditioned areas. It is wasteful to provide lighting and ventilation for a large area that is used by only a few people or to operate a dormitory at partial occupancy.
- Schedule janitorial services for when the building is occupied.
- Do not alter temperature schedules for people working after hours. In special circumstances, this policy may not be feasible and a designated area should be provided for after hours work rather than condition the entire building.
- Reduce elevator usage by improved scheduling. Use the stairs instead of the elevator when possible.
- Drinking fountains are small items, typically about 200 watts, but there is no need for continual operation. Use time clocks to shut them off during unoccupied hours.



ENERGY CONSERVATION PUBLICATIONS



Listed below are publication that will provide additional information. "NTIS" refers to National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia, 22161. "GPO" publications are available from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C., 20402. Some of the publications listed include extensive bibliographies for further references.

Energy Conservation Applied to Office Lighting. The report reviews the literature and findings upon which the past practice of lighting design has been based, and makes recommendations and suggestions for changes that can be instituted to make lighting design and installation in the future more responsive to the needs of energy conservation (288 pp).

NTIS: PB-244-154\$9.25

Evaluation of Building Characteristics Relative to Energy Consumption in Office Buildings. The report presents a survey of office building factors which impact energy consumption. It offers a baseline for future research in buildings energy consumption monitoring (69 pp).

NTIS: PB-248-774/2ST\$4.50

Guidelines for Saving Energy in Existing Buildings. Building Owners and Operators Manual: ECM I. This report examines national energy usage in existing commercial buildings, methods of reducing energy consumption, and the resulting costs and benefits. It describes options and minor modifications to buildings and mechanical and electrical systems that can be implemented immediately with little if any investment cost (299 pp).

NTIS: PB-249-928\$9.25

GPO: 041-018-00079-8\$5.25

Guidelines for Saving Energy in Existing Building. Engineers, Architects, and Operators Manual: ECM 2. Additional ways for lowering operating costs are presented (448 pp).

NTIS: PB-249-929\$10.00

GPO: 041-018-00080-1\$5.05

Lighting and Thermal Operations. This publication contains guidelines which represent desirable targets for illumination levels, lighting efficiency, and operation of heating and cooling systems. It is based upon a study of 19 Federal office buildings. Energy consumptions are listed, before and after implementation of the energy conservation programs which included recommendations for illumination, thermostat settings, building occupancy, and fan operation (20 pp).

NTIS: PB-245-047\$4.50

Physical Characteristics, Energy consumptions, and Related Institutional Factors in the Commercial Sector. This report addresses the physical characteristics of existing commercial buildings in Baltimore, Maryland and Denver, Colorado with emphasis upon factors related to constructing and/or operating energy efficient commercial buildings.

NTIS: PB-249-470\$7.50
GPO: 041-018-00130-1\$2.50

Guide to Energy Conservation for Good Service. This paper discusses how to conserve energy in a food service establishment (74 pp).

NTIS: PB-249-462\$5.00
GPO: 041-018-00127-1\$2.25

Assessment of the Potential for Energy Conservation Through Improved Industrial Boiler Efficiency: Volume 1. This volume concentrates upon boiler efficiency for the use of three fuels—gas, oil and coal. On-site tests were made to determine the “as found” operating conditions of selected boilers. These tests revealed areas of poor maintenance that had a direct impact on boiler efficiency and fuel use. The report states the significant near-term savings that can be achieved by a relatively inexpensive boiler maintenance program (276 pp).

NTIS: PB-262-576/AS\$9.25

HANDBOOKS

Handbook and Product Directory. American Society of Heating, Refrigerating and AirConditioning Engineers. 4 Volumes.

1978 APPLICATIONS

1977 FUNDAMENTALS

1976 SYSTEMS

1975 EQUIPMENT

Lighting Handbook. Illuminating Engineering Society. Fifth Edition. 1972.

Information is also available from Mr. Joseph Ziegler, Energy Planning Division, DNRC, 32 South Ewing, Helena, MT. Telephone 449-3940. Publications available include the following:

The Montana Energy Conservation Plan. Overview of Montana’s energy policy.

Total Energy Management: A Practical Handbook on Energy Conservation and Management. This handbook provides a practical approach for implementing energy conservation procedures (61 pp).



